LUBRICATION

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We invite correspondence from all those interested.

Those who fail to receive LUBRICATION promptly, will please notify us at once and will confer a favor by promptly reporting change of address.

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EDITORIAL

The relation between the economical use of gasoline for power purposes in internal combustion motors and the proper lubrication of the motor, has not received the attention which the subject deserves. This has probably been due to the fact that up to a short time ago, the fuel used in such motors was sufficiently inexpensive to make the question of economy a minor point.

With the rapid growth of the motor industry, however, and the consequent bringing into use large numbers of cars, with the excessive drain upon the supply of gasoline, the situation has entirely changed. The amount of crude oil production for the entire world for the last two years has not grown to any appreciable extent. The growth for the year 1911 over 1910 was less than 1%, and with the slightly decreasing conditions in the American fields for 1912, it is probable that this growth is entirely wiped out.

Only a certain proportion of this crude petroleum is available for the manufacture of gasoline and in the U. S. the available production for gasoline purposes has decreased since 1910, while the production of motor vehicles has increased nearly 200%. As a result there is a shortage in the supply of gasoline with no immediate hope of increased production in the future and a consequent steadily increasing value.

Under these circumstances, anything which will show possibility of a more economical use of motor fuel by careful consideration of the lubricating conditions, is of the utmost importance.

We have stated in this magazine, and we have repeatedly shown in our own tests (and in tests, the results of which have reached us from other sources) that one of the greatest and probably the most direct cause of loss of power from the gasoline motor, is due to the leakage of the mixture past the piston during the compression stroke.

During the compression stroke, the mixture of gas and air is compressed to 60 or 75 lbs., and under such circumstances any possible avenue of

escape for any portion of the mixture will result in leakage.

Inasmuch as the valves are closed tightly during this stroke, the only other possibility of escape is past the piston between the piston rings and the cylinder wall. However tightly such piston rings are fitted, short of freezing the motor, there must be sufficient clearance between the piston rings and the cylinder walls to form a sliding fit, this space being filled with lubricating oil to prevent wear and tear from friction. Unless the clearances are so arranged that a reasonable easy sliding fit is secured, loss of power will occur on account of the increased absorption of such power in turning over the motor. If the clearances are sufficient to provide the easy sliding fit necessary for good mechanical conditions, the function of preventing an escape of the mixture past the piston rings must be performed by the lubricating oil.

In a number of tests made in our own laboratory with a 60 H.P. motor, 6 cylinder, 4 cycle type, we found that a number of oils in the crank case, after an eight-hour run, became very much lighter in body, lower in flash point and consequently lower in lubricating quality.

In investigating this matter, we found that it was usual for racing drivers after a race to dump out the oil from the crank case, their expression being that "it was shot to pieces" and so thin that it was like water.

Further tests in investigation showed that the lowering of the flash point, the viscosity, etc., of the oil was due to the admixture of gasoline which had escaped from the cylinders past the piston rings into the crank case, and had recondensed with a consequent deteriorating effect upon the lubricant.

In one case this admixture was so marked that where the crank case had been left open for some hours, the vapor arising from the gasoline contained in the lubricating oil was enough to cause an explosion on applying a light.

Experience in all other lines of lubrication have shown that an oil *increases* in body under continued use and does not decrease in body and flash as in this case. The only way in which such decrease in body and flash could occur is by the admixture of a lighter product.

A series of further tests and investigations showed that with Texaco Motor Oil—even the lightest grade—we got no reduction in the viscosity or flash point after several hours running, and at the same time we got an increase of power with the same amount of gasoline. Innumerable road tests have shown the same result, which means that Texaco Motor Oil has a characteristic of unusual tenacity, sealing up the space between the piston rings and the cylinder walls so that there is no possibility of escape of the gasoline and air mixture during the compression stroke. This characteristic of Texaco Motor Oils results in two things:

1: A reduction in the amount of gasoline required for the same power or the same mileage.

2: A reduction in the amount of lubricating oil used, because there is no mixture of gasoline with the lubricant, and consequently little deterioration.

In one of the tests mentioned in this book, it will be noted that the saving of gasoline in this way was as high as 28% and the saving of lubricating oil as high as 33⅓%.

These remarkable results which have been obtained continually in tests covering hundreds of conditions for over a year, mean that the user of Texaco Motor Oil not only gets proper lubrication and reduces the consumption of lubricating oil, but

also secures an unusual economy in the consumption of gasoline per mile or per H.P. on account of the absence of any leakage.

These tests show conclusively the importance of Texaco Motor Oil in the economical operation of the motor over all ordinary conditions.

CARBURETTER ADJUSTMENTS

Should there be unlimited supply of crude oil from one district and an unlimited supply of gasoline made from this crude, there would be no carburetter difficulties, as all the carburetters made could be adjusted to take the one grade of gasoline, and this adjustment would never have to be varied.

The condition that confronts us today, however, is almost the opposite of the above ideal one. The crude, which bears a large proportion of the gasoline, is fast becoming reduced in quantity. The other crudes, which are being worked to a very large extent, give gasoline of somewhat different tests. Some of these other crudes, principally the Mid-Continental or Southern Crudes, allow gasoline to be made which, by all of the tests—both practical and technical—shows that greater power can be developed in an engine, though in same instances different adjustments of the carburetter must be made.

It has recently been stated by a representative of one of the large companies that the reason for the change in the gasoline, which his company is putting out, was that they were cutting deeper into the kerosene distillate. This cutting deeper means that the gravity of the gasoline is being gradually lowered. This lowering of the gravity and increasing the range of boiling of the gasoline requires new carburetters, or carburetters having a wide range to make the necessary mixtures. The following practical test will show the effect of adjusting the carburetter, as well as the difference between gasoline made out of Northern and gasoline made out of Southern crudes:

The car was a 1913 product, turned out by a Western manufacturer. It was used on road test under the guidance of a chief tester, who was perfectly familiar with the adjustment of their stock carburetters. During the entire test the motor was lubricated with Texaco Motor Oil Medium. In order to test the gasoline, a one-gallon can was placed in the car with an independent pipe leading to the carburetter. This can was filled with enough of a competitive gasoline to properly adjust the carburetter, and after this was done the can was drained dry. The main tank was shut off and disconnected from the carburetter; the one-gallon can was connected and filled with one gallon of the competitive gasoline. The run was then started with a set spark and throttle, which gave continuous speed of 25 miles per hour, and this speed was maintained until the motor stopped. The speed indicator showed that a distance of 10.5 miles had been made on one gallon of gasoline.

After this first test, enough of the Texaco gasoline was used to adjust the carburetter for air mixture, after which one gallon of Texaco gasoline was measured into the can and the car run over the same road as before with the same spark and throttle adjustment as on the previous test. The motor stopped as soon as the gasoline became exhausted, and it was found that the car had traveled 10.8 miles on Texaco gasoline. After this test, the carburetter was adjusted in accordance with our expert's opinion of

what it should be in order for the motor to obtain the best results with the use of Texaco gasoline.

Driving under the same conditions with a set spark and throttle at a speed of 25 miles an hour, with a measured amount of gasoline in the test can, it was found that one gallon of Texaco gasoline allowed the car to travel 13.5 miles. It was also found that the former competitive gasoline would not operate with the carburetter fixed in the position of the last test.

This short test indicated quite clearly that with the same carburetter adjustment Texaco gasoline would allow .3 of a mile per gallon more to be made, and with the proper adjustment three miles more per gallon would be secured out of the Texaco gasoline.

AN INTERESTING AND CONCLUSIVE TEST ON TEXACO MOTOR OIL

In the testing room of a well known motor manufacturing company of Connecticut, two four cylinder motor engines, 1913 design, were carefully cleaned and set up on testing blocks for the lubricating tests. A competitive oil of very high grade, made from paraffine base oil was used to lubricate one motor, while Texaco Motor Oil L was used on the other. The object of the test was to see which oil would give the best all round results in lubricating this particular class of motor.

The motors were adjusted and started on a three day continuous test, during which time they were kept at a speed of about 800 R.P.M. Both of the motors were attached to the same gasoline tank, using the same make of carburetter and magneto, and all the conditions surrounding the motors were as nearly equal as possible. Utmost care was taken that all surrounding conditions would be the same so that the results of the test would show the actual lubricating value of the oils being tested. During these tests, the amounts of oil fed were as follows:

Date	*Quantity Texaco*	*Quantity Competitive*	*R. P. M.*	*Hours Run*
Dec. 5	3 gals.	3 gals.	800	9
" 6	1.5 "	1 "	800	9
" 7	1 "	0.5 "	800	9
" 9	1.25 "	1 "	900	9

Up to this point the feeds were being adjusted, and although the drops seemed to be alike in both lubricators, the drops of Texaco Motor Oil were considerably larger, and the pet cocks showed a larger amount being fed to the cylinders, and there was more free oil going out with the exhaust on the engine being lubricated with Texaco Motor Oil than with the competitive oil. On the 9th the motors were inspected, and the same amount of carbon was found in each motor. The carbon, however, in the motor being lubricated with Texaco Oil was of a soft, sooty nature, while the carbon in the motor being lubricated with the competitive oil was hard and flinty.

On completion of the test, the valves and plugs were taken out of

both motors. Considerable hard carbon deposit was found both on the heads and the inside valve ports on the motor being lubricated with competitive oil, the carbon being caked on one valve about 1/8" thick; this carbon had to be scraped and chipped off. The valves on the motor using Texaco Motor Oil had very little carbon, and that little was soft and was easily removed with a rag.

The valves in the motor using competitive oil were quite dry when taken out. The valves in the motor using Texaco Motor Oil were wet with oil.

On examining the spark plugs, it was found that they showed very little carbon, but it was hard and flinty where competitive oil had been used, and soft and wet where Texaco Motor Oil was used. The sparking, however, was not interrupted in either case.

Inspections were made by the superintendent, the assistant superintendent, the foreman of testing, and different demonstrators in connection with The Texas Company's engineer. They all agreed that the showing was very favorable to the Texas Company oil, and considerable surprise was expressed that there should be such a difference in the lubricating effects of the two oils.

After the inspection was completed, the motors were thoroughly cleaned. This cleaning process further emphasized the value of Texaco oils, as the carbon on the valves and in the cylinders, where Texaco oil was used, required but several minutes to clean. Cleaning the motor in which the competitive oil was used required several hours' time in scraping and chipping away the hard carbon deposits.

Date	*Quantity Texaco*	*Quantity Competitive*	*R.P.M.*	*Hours Run*
Dec. 11, A.M.	1.5 gals.	1 gals.	900	4.5
" 11, P.M.	1 "	0.75 "	900	4.5
" 12, A.M.	0.75 "	0.75 "	1000	4.5
" 12, P.M.	1 "	1 "	1000	4.5
" 13	1 "	1.25 "	1000	3

The motors were again set up on the test block and further tests started at a reduced feed of oil. The test was continued on a greatly reduced amount of Texaco Oil until December 16, when the two motors were taken out of the testing room, put in cars and given a three days' road test. The plan of taking road test was to have two cars exactly alike, each one fitted with one of the motors used in the foregoing test. These cars were to be kept on the road; they were to travel together, start and stop at the same time, making the same speed throughout the test. The same kind of gasoline was used in both motors, the equipment was exactly the same in regard to the motors as on the block test.

The first test was completed in twenty-seven hours, during which time the cars had run 328 miles with an allowance of 4.5 gallons of motor oil to each car; that would make a gallonage per mile of .01372 gallons, or miles per gallon of 74 miles. Upon completion of this first road test, the valves and plugs of each motor were removed, and the motor which was using competitive oil showed dry with a hard carbon deposit, and the motor using Texaco oil showed wet with an

excessive amount of oil and some soft carbon deposit. In regard to the amount of carbon, it was considered that slightly more was found in the motor using competitive oil than in the one using Texaco oil, though there seemed to be more carbon on the plugs in the motor using Texaco oil; this carbon, however, was sooty in nature and easily removed.

Owing to the excessive amount of oil in the motor using Texaco Oil, it was decided to run a second three-day test on a reduced amount of oil to the cylinders, the first test being made on a feed of twenty drops per minute. This was reduced to five drops. On the motor using competitive oil it was decided that it would be best not to reduce the amount of oil fed to the cylinders to a great extent, as the cylinders upon examination showed dry with no excess of oil, and it was considered injurious to reduce the amount below 20 drops.

The second road test required 18 hours, during which time the cars ran 204 miles and used 2⅞ gallons of motor oil on each car. The gallonage per mile was .01409 gallons, and the miles per gallon were 70.96 miles. Inasmuch as the feed from the lubricators into the cylinders was reduced from 20 to 5 drops in the case of Texaco oil, and 31 to 20 drops in the case of competitive oil, the fact that the same amount was used in both cars during this test is explained by there being a greater consumption of oil from splash feed.

Summarizing the results of the block and road test, the following facts were arrived at:—

LUBRICATION:

There was always an excessive quantity of oil on the cylinder walls of the motor using Texaco Oil. The valves and all internal parts of the engine were well covered with oil. With the competitive oil, an examination showed a general dryness of the internal parts—so much so that it was considered inadvisable to make any reduction in the amount of oil being fed.

CARBON:

Examinations after all the tests showed that the carbon deposit, while using the competitive oil, was of a hard, flinty nature, very difficult to remove, and that this carbon was always greater in amount compared to the amount of carbon found in the other motor. The carbon formed by Texaco Motor Oil was light and sooty; it was easily removed and was very much less in quantity than that found in the other engine.

SMOKE:

The same in both cases.

QUANTITY:

This was greatly in favor of Texaco Motor Oils in the block test. While the total consumption for each engine was the same during the road tests, the distribution was different, less going to the cylinders with Texaco Oil than with the competitive oil.

REPORT

on very thorough test of Texaco motor oil and gasoline against regular market gasoline with motor oil supplied by the same competitive firm

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This test was made on a motor which was coupled up to a generator. The generator was operated on a steady load; readings were taken at regular intervals, and the tests were operated for certain fixed periods, after which the fuel and lubricating oil consumed were checked up with the supply left in the tanks and in the crank case. The tests were made on the same motor, which was carefully cleaned and placed in the same condition for each series of tests The object of the test was to show the difference in the lubricating value of Texaco Motor Oils and motor oils supplied by one of our largest competitors; and also at the same time to show the difference in the value of Texaco gasoline as compared to gasoline furnished by the same competitor. The utmost care was taken in having all conditions in connection with these tests uniform so that nothing whatever would affect the results, other than the difference in the quality of the lubricating oil and gasoline. Considerable time was taken in getting the motor arranged for this test. The following results were obtained with the engine running light:

It was found on this test that the carburetter used was so designed or constructed that very little range was obtainable. It was also interesting to note that the gravity of both the competitive gasoline and Texaco gasoline was the same. The difference in the readings were therefore due to the difference in the quality of the lubricating oil and gasoline:

Block Test

Competitive Motor Oil and Gasoline (Nov. 13, 1912)

Motor No. 1529
R.P.M., 1000
Hours run, 8
Miles per hour, 25.95
" " 8 hours, 127.6
" " gallon of gasoline, 12.4
" " " " lubricating oil, 102.8
Gasoline consumption per 8 hours, 10.25 gallons
Lubricating oil consumption per 8 hours, 1.25 gallons

Texaco Motor Oil, Medium, and Gasoline (Nov. 19, 1912)

Motor No. 1529
R.P.M., 1000
Hours run, 8
Miles per hour, 25.95
" " 8 hours, 127.6
" " gallon of gasoline, 18.1
" " " " lubricating oil, 135.9
Gasoline consumption per 8 hours, 7.04 gallons
Lubricating oil consumption per 8 hours, .937 gallons

Results During Use of Texaco Oil and Gasoline

Increase in miles per gallon of gasoline of 5.7 miles or 31%
Increase in miles per gallon of lubricating oil of 33.1 miles or 24%
Decrease in gasoline consumption per 8 hours run of 3.21 gallons or 31.3%
Decrease in lubricating oil consumption per 8 hours run of .313 gallons or 24%
Mileage figured on 1000 R.P.M. of motor, 4 to 1 gear ratio and 35″ wheels

The second test was on the basis of the power development by the motor. The power was measured very carefully with special instruments, readings being made at regular intervals. During the complete series of tests, the motor was maintained at a constant speed of 1000 R.P.M. In regard to the lubricating oils, in the case of both competitive oil and Texaco oil, no attempt was made to regulate or reduce the drops per minute being fed to the four cylinders and the three main bearings, so that the reductions shown in the amount of lubricating oil used were due to the more suitable character of the Texaco Oil. The field voltage in the generator was maintained constant for the entire test, and so the increase in horse power developed during the use of Texaco Oils was due entirely to the better lubricating properties of the oil, and the higher power secured through the use of the gasoline. It is not due to a higher field pressure (voltage) or to any other feature. The tests were made under the personal supervision of the works' experts working in connection with the engineers of The Texas Company.

The tabulated results are as follows:

Block Power Test

Competitive Oil and Gasoline (Nov. 14, 1912)

Motor No. 1529, R.P.M. 1000

Average H.P. developed (seven hourly readings)	9.92	H.P.
Gasoline consumption per 7 hours run	17.875	gals.
Gasoline consumption per 9.22 H.P. hour	2.553	"
Lubricating oil consumption per 7 hours run	1.125	"
Lubricating oil consumption per 9.92 H.P. hours	.1607	"

Texaco Oil and Gasoline (Nov. 20, 1912)

Motor No. 1529. R.P.M. 1000

Average H.P. developed (seven hourly readings)	10.14	H.P.
Gasoline consumption per 7 hours run	12.688	gals.
Gasoline consumption per 10.14 H.P. run	1.812	"
Lubricating oil consumption per 7 hours run	.75	"
Lubricating oil consumption per 10.14 H.P. hour	.107	"

Results

Increase in average H.P. developed	22 H.P.	or	2.1%
Reduction in gasoline consumption per 7 hours	5.187 gals.	"	28%
Reduction in lubricating oil consumption per 7 hours	.375 "	"	33%
Reduction in gasoline consumption per 10 H.P. hours	.741 "	"	28%
Reduction in lubricating oil consumption per 10 H.P. hrs.	.0537 "	"	33%

The mileage in each case was assumed and based upon 1000 R.P.M., 4 to 1 gear ratio, 35″ wheels.

This shows a very remarkable increase in the efficiency of the motor. The greater horse power developed with the less consumption of gasoline and lubricating oil is exactly as it should be, knowing, as we do, that both Texaco Motor Oils and Texaco gasolines are very high in efficiency. After each series of tests the motors were opened and carefully examined; whatever carbon was deposited was carefully removed so it could be examined. It was noted that the carbon deposited in the engine while competitive oil was being tested was hard in character. The carbon which was formed during the use of Texaco Oil was of a soft nature.

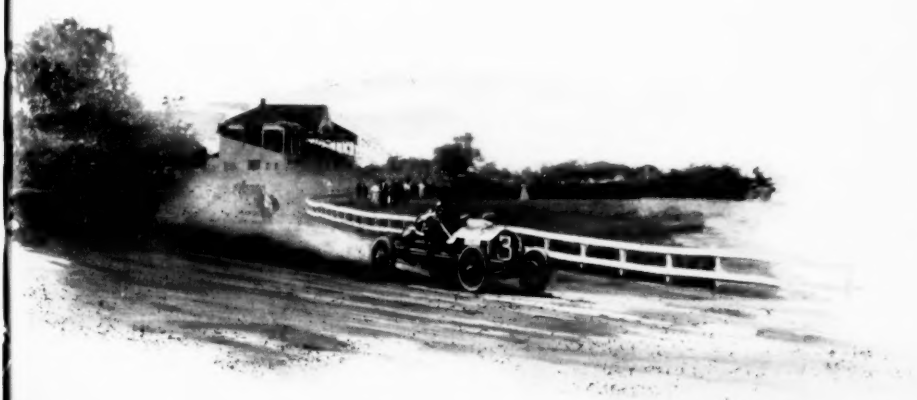
The entire results of the test proved conclusively that the combination of Texaco Motor Oil and Texaco Gasoline will greatly increase the mechanical efficiency of the motor as a unit. This increase in efficiency was obtained with a reduced consumption of gasoline and a reduced consumption of lubricating oil. No adjustments whatever were made that would in any way affect the reduced amount of gasoline and lubricating oil being used. The reduction in the amounts used came about entirely through the character of the Texaco Motor Oil. This Motor Oil was evidently of a more tenacious nature than the competitive motor oil. The oil formed much better compression or seal. This affected the gasoline consumption, as the greater the compression, the less will be the leakage during the compression stroke.

The entire test, as shown by all of the figures, is consistent to the last degree, and shows conclusively what may be accomplished by our very fine combination of high grade motor oil and gasoline.

Previous to the time the above tesst were made, tests on all of the prominently advertised brands of motor oil were conducted. Finally the oil was selected which gave the best mechanical efficiency results; this is the oil against which our Texaco Motor Oil was tested.

In the concluding report to the manufacturers, the consulting engineer of the plant stated that the frictional load on the motor had been reduced and the compression increased by the use of Texaco Motor Oil; further, that 25% less oil was used, and comparison of the carbon removed from the cylinders after each test showed, by actual weight, 75% less carbon had been formed by Texaco Motor Oil.

The final result of the test was that the motor manufacturers contracted with us for all oils and will recommend our Texaco Motor Oil.



INSTRUMENTS FOR MOTOR TESTING

In connection with the development of our motor oils and the work on the block tests of various motor manufacturers, it was not long before the developments showed the necessity of some instrument which would give in a graphic manner a picture of what was taking place inside the cylinder during the compression and explosion strokes.

We found that in almost all the testing rooms, the men in charge were getting some indication as to the condition in the cylinder by opening the pet cock on top of the cylinder or above the exhaust valve, and placing their hands over this opening in the gas from the explosion. It developed that these men had so trained themselves from continued practice in this regard, that it was possible for them in this way to secure a rough and approximate idea of the situation.

In order to study this matter on as nearly a scientific basis as possible, so that proper records could be kept to preserve the history in each case, we originated and designed an instrument (as illustrated) by the use of which we are able to make explosion pictures illustrating the conditions in the cylinders in a somewhat remarkable manner.

A certain standard sized pet cock is screwed into the opening above the cylinder or exhaust valve and the instrument firmly clamped in position, in the holder is placed a piece of heavy, partially absorbent paper in a proper position to receive the gas as it blows through the pet cock. In practical use a record is made of a

certain number of explosions; should there be any excess of lubricating oil getting up by the rings, it will show on the paper. Should there be no lubricating oil whatever, the paper will indicate the heat from the explosion. Should the oil which gets up past the rings be turned to carbon, this will also show.

A rather accurate and careful study of the variations in these records will allow of a determination of the amount of oil to be carried or fed to the different parts of the motor. These records can, in fact, be calibrated in such manner as to show in any one test any changes necessary and the reasons for such change.

This instrument enables the testing engineer at a factory to keep in close touch all the time with the lubricating conditions in the motor, and it is not necessary, as was formerly the case, to wait until the end of a four, eight or ten hour run and then dismantle in order to find out the conditions.

Realizing that such an instrument will be of great advantage to the motor manufacturer who would have opportunities for the further investigation and study both of the motor and of the instrument, in a way not possible with our own engineers, and also appreciating the value of any more exact method of determining the lubricating requirements of a motor, we decided not to patent this particular invention, but simply to present it to the engineers connected with the motor industry as a suggestion which from our experience we had found of great value, which had the advantage of actually picturing cylinder conditions and which can be an aid to scientific investigation. We have attached no strings to the use of this instrument in any way whatsoever. It has been useful to us in solving some problems which could not be readily determined from the

ordinary methods of motor testing in use. It is quite possible that it could be made to solve other problems in the same way, if a careful investigation was made under a sufficient number of continuous tests under various block conditions and with various types of motors.

The illustrations show the instrument so that its working can be thoroughly understood.

If any of the readers of this publication would like to receive further information on the subject of this instrument, we will be glad to forward it to them on request.

SHORTAGE IN THE GASOLINE SUPPLY

By Mr. William T. Magruder

Prof. Mechanical Engineering, Ohio State University

(Discussion before the American Society of Mechanical Engineers)

The smaller proportionate number of motor cars used in England as compared with this country is doubtless due to the relative prices of suitable fuel. I was informed that there are 150,000 motor cars in Great Britain for a population of fifty million people, or about three cars per 1,000 of inhabitants. In this country almost 1,000,000 motor cars were registered in 1912, to say nothing of the motorcycles, motor boats and other users of oil-power; or one car for each 100 of the inhabitants of the United States, and that the ratio of cars to people in this country is three and one-third times as large as in Great Britain. If there were the same proportionate number of cars used in Great Britain and on the Continent, for which I have no accurate figures, as in America, the price of fuel in Europe would be still greater than it is. But to this large number of motor-car engines must be added more than one million gasoline engines used for farm work and in motor boats in this country. Taking the average horsepower of the motor cars to be 25 and of the motor boats and farm engines to be 10, thirty-five million horsepower of gasoline engines are immediately available for the practical generation of power in this country. Suppose they used as a minimum at rated load three-quarter pound or one pint of gasoline per horsepower per hour for one hour of use they would generate thirty-five million horsepower and require four and a half million gallons of gasoline at an estimated cost of $700,000. The total annual supply of American gasoline is estimated to be one billion, five hundred million gallons, and that would last only 333 hours. If every gasoline engine were run at its rated load each day, the annual distillation of gasoline in this country would be sufficient to permit them to be operated for only one hour per day, or 333 hours per year. In other words, our present annual output of gasoline is sufficient to operate continually at their rated load only five per cent. of the gasoline engines now sold and in operation.

These being the facts as I gather them from statistics published by the Bureau of Mines, and other reliable sources, it can readily be seen to be a case of supply and demand. It is probable that some other fuel than gasoline must come into use for oil engines and that this fuel will be kerosene. When the vast amount of kerosene that is now on the market is realized, three billions of gallons being distilled annually, it seems certain that kerosene oil will come into very great and general use in the next few years.